

BRUSH WELLMAN INC.
BERYLLIUM HEALTH AND SAFETY UPDATE
MARCH 2002

This communication summarizes recent developments concerning the definition of and testing for chronic beryllium disease (CBD), beryllium health research, changes to Brush Wellman's programs for promoting the safe handling of beryllium, and the status of occupational standards. For important health, safety and environmental information on the use of specific beryllium-containing materials, please see the product specific material safety data sheet (MSDS).

Defining Chronic Beryllium Disease

In order to contract CBD, an individual must be exposed to airborne beryllium in the form of a dust, mist or fume. This particulate must be small enough to reach the air sacs deep in the lungs and the individual must be sensitive to beryllium. Not all individuals exposed to airborne beryllium particulate will become sensitized and of those who become sensitized, not all will develop CBD. Scientists believe that the capacity to develop sensitivity to beryllium is genetically determined and that most people are not susceptible to becoming sensitized.

Before the late 1980's, workers were diagnosed with CBD only when they exhibited clinical (observable) symptoms of CBD and changes in their chest x-ray or lung function test. Symptoms could include unexplained dry cough; shortness of breath, especially with activity; and fatigue. During the late 1980's and early 1990's, the criteria by which CBD was diagnosed changed, and workers began to be diagnosed with CBD without clinical symptoms or measurable impairment. This diagnosis became possible as a result of the application of new technology in medical testing and evaluation. Workers diagnosed with CBD in the absence of x-ray or lung function changes or symptoms of disease are referred to as having sub-clinical CBD, meaning that they have no clinical symptoms or measurable impairment. Workers with sub-clinical CBD may never develop clinical CBD or may develop clinical CBD over time.

Use of Beryllium Blood Lymphocyte Proliferation Testing

The beryllium industry has long sought a practical and useful test that was capable of reliably predicting those individuals who may be susceptible to contracting CBD. No such test has yet been developed. A blood test, the beryllium blood lymphocyte proliferation test (BeBLPT), may be used to indicate whether a person is sensitized to beryllium. Sensitization to beryllium is not an illness or disability. The BeBLPT is a laboratory test to measure if a response occurs when a water-soluble beryllium compound is added to immune cells isolated from a blood sample. The BeBLPT, in and of itself, does not detect sub-clinical or clinical CBD. Individuals who have a positive BeBLPT may be referred to a lung specialist for consultation to decide whether to undergo additional specific medical tests which are necessary to determine if sub-clinical or clinical CBD is present. Diagnosing sub-clinical CBD requires a biopsy to obtain samples of lung tissue using a procedure called bronchoscopy. Bronchoscopy with lung biopsy has its own associated health risks, such as a collapsed lung, bleeding or infection and a possibility of death.

It is important to note that substantial disagreement in test results exists when test data are compared within and between the laboratories that conduct the BeBLPT. Studies have shown that laboratories which detected a positive result on a first blood test find a negative result 30% of the time on a second blood test on the same person. When two different labs (Labs A and B) tested the same blood sample, Lab A did not confirm 30% of Lab B positive results and Lab B

did not confirm 30% of Lab A positive results. Additionally, some individuals who test consistently positive at one point in time may test consistently negative at a later point in time.

Brush Wellman has now completed BeBLPT testing of over 300 new workers before they began working in a beryllium plant and found that 1-2% of these workers test positive for sensitivity to beryllium. Similar results have been noted by independent laboratories from around the United States on tests of persons who have never worked in a plant using beryllium. It is not known why persons not occupationally exposed to beryllium can test positive.

Because of these and other factors, the BeBLPT does not at this time meet the criteria as a screening test for CBD. Screening refers to the early detection of pre-clinical disease in persons without signs or symptoms suggestive of the disease with the requirement that this detection be of medical benefit. In a recent affidavit, Stephen H. Woolf, M.D., an expert on public health screening who has served as science advisor to the U.S. Department of Health and Human Services' Preventive Services Task Force, has stated, "Under contemporary scientific principles of accepted medical practice, screening for CBD is not medically reasonable or necessary for workers regularly exposed to airborne beryllium..." Dr. Woolf further states, "Testing for CBD is appropriate clinical practice only for diagnostic purposes, based on the symptomology of individual patients, or in the context of experimental studies." In other words, he is saying the test should only be used for persons with clinical symptoms which may be a result of beryllium exposure or in the context of well defined research. Despite its limitations, Brush Wellman uses the BeBLPT as a tool to target work areas and specific jobs for improved exposure controls and to evaluate the effectiveness of exposure controls in the work place. However, Brush Wellman does not use or recommend BeBLPT as a screening test for CBD.

Research Review

A significant amount of scientific investigation and research has been, and will continue to be, conducted regarding the health effects of exposure to beryllium. Much of this investigation and research has been conducted by or in cooperation with Brush Wellman Inc. In 1998, the National Institute for Occupational Safety and Health (NIOSH) and Brush Wellman entered into a formal agreement to collaborate on medical surveillance and industrial hygiene studies to better understand the causes and prevention of beryllium-related health effects. In addition to active collaboration, Brush Wellman supports access of NIOSH to Brush Wellman employees and work places for independent research. Currently, these include studies of genetic risk factors for beryllium sensitization and disease, and the interaction of genetic and environmental factors. Investigation and research have been focused on:

- The natural history and predictors of health outcomes in sensitized persons and persons diagnosed with CBD (sub-clinical and clinical chronic beryllium disease).
- How often, when, why and in what way sensitization progresses to a process which affects the lungs.
- Characterization of skin exposures and the possible relationship of these exposures to beryllium sensitization.
- Medical surveillance as it relates to work history, chemical form of beryllium and measurements of airborne beryllium particulate to determine beryllium sensitization and CBD.
- The reliability, variability and interpretation of the BeBLPT and its usefulness as a predictor of CBD.
- Characterizing particle size distributions and counts in air and on surfaces, and their relationship to beryllium sensitization and CBD.

- Identifying a better measure of risk than total mass exposure such as particle number, chemistry and shape.
- The relationship between genetic factors and beryllium sensitization and CBD.

Although much of the scientific investigation and research is ongoing, there are several important findings that have emerged. The following is a summary of these findings:

Reading, Pennsylvania Plant Survey

Preliminary results from the 2000 survey of the Brush Wellman Reading, Pennsylvania facility have shown that sensitization and sub-clinical CBD can occur when airborne beryllium levels have been mainly below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) of 2 micrograms of beryllium per cubic meter of air ($\mu\text{g}/\text{m}^3$). This survey was conducted as part of a Brush Wellman and NIOSH research partnership. This facility processes alloys containing 0.1 to 2.0% beryllium and manufactures thin gauge strip and wire products using a variety of processes including rolling, drawing, pickling, annealing, heat treating, degreasing and welding. Of the 152 workers who participated in the survey, five were diagnosed with sub-clinical CBD. A review of the work histories of the five workers revealed that they all had worked at the facility within the past 20 years when air sample results have almost always been below the PEL (less than 3% of air samples above $2 \mu\text{g}/\text{m}^3$). No cases of clinical CBD were found as part of this survey. Prior to conducting this survey, two cases of CBD had been identified at this facility since Brush Wellman purchased it in 1958. One of these workers was diagnosed in 1974 as a result of having clinical symptoms and measurable impairment. This clinical CBD case is believed to have been caused by excessive exposure to fumes containing beryllium from a copper beryllium welding operation conducted in the 1960's. The second worker was diagnosed after a positive BeBLPT was obtained in 1999. This worker had no significant symptoms or measurable impairment prior to diagnosis.

In some earlier beryllium studies, office workers had been found to be at risk for getting CBD. Therefore, it is notable that this recent survey found no office workers who tested positive BeBLPT or who were diagnosed with sub-clinical CBD. Office workers often walked through production areas as part of performing their regular duties. This survey also revealed that workers who had tested sensitive to beryllium or those diagnosed with sub-clinical CBD all worked in or around the annealing ($>1,400^\circ\text{F}$) and/or pickling (strong acid/caustic cleaning) operations. Particle size air sample testing has found that these operations generate a larger number of small particles (<1 micrometer) containing beryllium compared with other operations at this facility. This survey supports the view that there is increased potential hazard associated with thermal treatments such as annealing, and places new emphasis on the potential hazards of pickling operations.

Delta, Utah Plant Study and Survey

Brush Resources operates beryllium mining and refining operations in Delta, Utah. Bertrandite ore is mined by Brush Resources from an open pit mine in the Topaz Spor Mountains in Utah. This ore, and beryl ore, which is imported from other regions of the world, are processed using mechanical, thermal and chemical techniques at the Delta facility to produce beryllium hydroxide. Beryllium hydroxide is the output material from the Delta operations and is the input material for the production of metallic beryllium, beryllium oxide and beryllium-containing alloys at the Brush Wellman Elmore, Ohio manufacturing facility.

A 1996 study at the Delta mine and refining operations did not find any cases of clinical or sub-clinical CBD among employees who had worked exclusively at the mine and/or refining plant. One case of clinical CBD was diagnosed during the 1996 study. However, this employee had worked at the Elmore facility for nearly ten years prior to relocating to the Delta facility. Air sample results at the Delta facilities have been comparable to levels at the Elmore facility which has experienced a significant number of cases of sub-clinical and clinical CBD. A more recent survey of the Delta facilities workforce in 2001 also revealed no cases of clinical or sub-clinical CBD among employees who had worked exclusively at the Delta facilities. In both the 1996 and the 2001 surveys, the percentage of workers who tested sensitive to beryllium was similar to the percentage of workers who tested sensitive at the Elmore facility. The results of these surveys suggest that exposure to certain chemical forms of beryllium may result in sensitization without risk of developing CBD.

Alloy Distribution Center Surveys

Preliminary analysis of the results from the surveys conducted in 2001 at the three Brush Wellman alloy distribution centers revealed one worker among the 95 workers tested who was sensitive to beryllium and that worker was later diagnosed with CBD. Two of the distribution centers process alloy strip products and the other distribution center processes bulk alloy products. Copper beryllium is the primary alloy processed at these facilities. Activities at the facilities processing alloy strip products include slitting, welding, receiving, packaging and shipping. Activities at the facility processing bulk alloy products include machining, thermal treatment, chemical cleaning (mild pickling), receiving, packaging and shipping. The one individual diagnosed with CBD was a long-time employee who worked exclusively as a shipper/receiver and was not involved with production operations. The source of this worker's exposure to beryllium remains under investigation. The overall results of this study and the general absence of confirmed positive BeBLPT results suggest that these work activities, as conducted within Brush Wellman, appear to have lower potential health risks than activities involving the manufacturing of beryllium and beryllium-containing materials.

Tucson, Arizona New Employee Surveillance

Preliminary results from the ongoing medical monitoring of newly hired employees at the Brush Wellman Tucson, Arizona ceramic facility since January 1999 indicate that implementation of expanded interventions appear to be successful at preventing worker sensitization to beryllium. These interventions include mandatory respiratory protection in processing areas, overgarment protection, skin protection, migration control, process isolation, training and education. None of these newly hired employees have tested positive for sensitivity to beryllium or have been diagnosed with sub-clinical or clinical CBD.

Atomic Weapons Establishment Study, Cardiff, Wales

A report published in 2001 on the potential exposure experience of an atomic weapons facility processing metallic beryllium in Cardiff, Wales (UK) found greater than 97% compliance with the $2 \mu\text{g}/\text{m}^3$ standard to be protective in preventing clinical CBD. Metallic beryllium parts were manufactured at the facility for 36 years using processes such as vacuum melting, powder production, pressing, machining, heat treatment and surface treatments. The facility observed strict and consistent use of engineering

controls, work practices, housekeeping and the use of personal protective equipment. All workers were required to wear a personal air monitor every day. Over 250,000 personal air monitoring samples for beryllium, covering the most recent 17-year period, were analyzed. Less than 3% of the personal air samples were found to exceed the $2 \mu\text{g}/\text{m}^3$ standard.

Of the more than 400 Cardiff workers employed between 1961 and 1997, no cases of clinical CBD were diagnosed using a traditional medical monitoring program of chest x-ray and lung function testing. One case of CBD was diagnosed during this period, but the study author characterized this case as “unique” based on a systemic reaction to beryllium oxide as reported by the treating physician. In the mid-1980’s, the Cardiff medical staff evaluated the BeBLPT but discontinued its use due to concerns with reliability. The study states that using expected rates of clinical CBD, the facility should have experienced 4 to 20 cases of clinical CBD during the 36-year period. The Cardiff study found that meeting the beryllium standard on a consistent basis, along with use of consistent work practices, engineering controls, housekeeping and personal protective equipment controls in a facility handling metallic beryllium, was effective in preventing clinical CBD.

Electrofusion Products Survey, Fremont, California

Analysis of the results from a survey conducted in 2001 at the Brush Wellman Electrofusion facility revealed no sensitivity to beryllium among 32 workers. This facility processes only metallic beryllium using mechanical means such as machining, polishing, sawing, welding, brazing and water-jet cutting; and chemical means such as plating, photoetching and milling. Airborne levels of beryllium at this facility have been maintained predominantly below the PEL for at least the last ten years (less than 1% of air samples greater than the PEL) with only occasional use of respiratory protection at this facility.

Summary

The above findings and findings by other researchers are providing insight into the potential pathways for exposure and causes of CBD. These findings indicate that a high level of compliance with the $2 \mu\text{g}/\text{m}^3$ standard can be protective at preventing clinical CBD, but not necessarily protective at preventing sensitization or sub-clinical CBD. These findings also indicate that chemical form, particle size and number, and specific processes can affect work-related risk. Preliminary findings indicate that the use of engineering and work practice controls have been effective at preventing sensitization, sub-clinical CBD and clinical CBD. These findings raise questions as to which health outcome (sensitivity to beryllium, sub-clinical CBD or clinical CBD) should be used to establish worker protection levels and whether the current methods used to measure compliance with the occupational standard are the best way for measuring potential risk to the worker. Continued research and evaluation is necessary to answer these questions.

While this important research and evaluation continues, Brush Wellman believes it remains the best practice to maintain levels of all forms of airborne beryllium as low as reasonably achievable, and continue to work to improve exposure control practices and procedures. Based on current knowledge gained from these surveys and studies, Brush Wellman has further enhanced its beryllium management program as described in the following section.

Beryllium Program Changes at Brush Wellman

Brush Wellman enhanced its beryllium programs by implementing a Health and Safety Management System (HSMS) and Beryllium Management Planning process to focus on its highest priority -- "the protection of people and the environment". The goal of the HSMS is to create a work environment that does not cause sensitization to beryllium, sub-clinical CBD or clinical CBD. The HSMS establishes a clear understanding of health and safety responsibilities among leadership, employees, contractors and visitors; integrates health and safety expectations into the business planning process; requires organizational structure/participation, education and training; and utilizes both leading and lagging measures of progress.

Users of beryllium-containing materials are reminded to perform workplace exposure characterization, including air monitoring, to determine if conditions or situations exist which dictate the need for additional industrial hygiene and improved work practices. Brush Wellman encourages those handling beryllium and beryllium-containing materials in ways which generate particulate containing beryllium to utilize engineering and work practice controls to keep beryllium work areas clean and to keep particulate containing beryllium out of the lungs, off the skin, off of clothing, in the work process, in the work area and on the plant site.

Status of Occupational Standards

American Conference of Governmental Industrial Hygienists Review of Beryllium

In 1999, the American Conference of Governmental Industrial Hygienists (ACGIH) proposed a revision to their occupational exposure standard for beryllium and published a "Draft Documentation of the Threshold Limit Values for Beryllium and Compounds". The ACGIH proposed to change the TLV-TWA (Threshold Limit Value –Time Weighted Average) for beryllium and compounds to 0.2 micrograms beryllium per cubic meter of air as an inhalable particulate, eliminate the STEL (Short-Term Exposure Limit) and classify beryllium as a sensitizer. The ACGIH placed the proposed changes in the 1999 TLVs® and BEIs® booklet as a Notice of Intended Changes.

On September 23, 1999, the ACGIH and Brush Wellman co-sponsored a scientific symposium on recent and planned health research data on beryllium. The symposium titled, *Beryllium: Effect on Worker Health*, was held in Washington D.C. It brought leading scientists together to review and discuss the current research on beryllium exposure and CBD. The information presented at this symposium was important in determining whether there was sufficient data to support a change of the current threshold limit value (TLV) for beryllium exposure and in providing guidance as to how new TLVs should be formulated.

The papers resulting from the 1999 symposium were published in the May 2001 edition of the scientific journal, Applied Occupational and Environmental Hygiene. Many of these papers can be viewed at www.brushwellman.com. Copies of the journal are available through the Brush Wellman Product Safety Hotline at **(800) 862-4118**.

After the 1999 symposium, the ACGIH postponed adoption of the proposed revisions to the TLV for beryllium and scheduled another major research symposium on beryllium for April 2002. The ACGIH and Brush Wellman have recently postponed this second symposium on beryllium citing that there has not been sufficient new information published and that most of the information from studies currently in progress is not yet available. The symposium has been rescheduled for Fall 2003. The ACGIH continues to postpone adoption of the proposed revisions to the TLV for beryllium.

OSHA Revises Its Regulatory Agenda Regarding Beryllium

OSHA first listed a Notice of Proposed Rulemaking (NPRM) for beryllium in the April 1998 semi-annual regulatory agenda. In the December 2001 regulatory agenda, OSHA proposed to issue a request-for-information on beryllium by September 2002. The beryllium rulemaking assessment is now classified as being in the pre-rule stage (pre-NPRM). During this timeframe, OSHA also has considered and denied a petition to issue an emergency temporary standard (ETS) for occupational exposure to beryllium.

How Brush Wellman Can Assist You

If you have any questions regarding the information provided, or wish to provide feedback, please contact your sales representative or call the Product Safety Hotline at **(800) 862-4118**. The hotline is staffed 24 hours per day in case of an emergency. If you would like a copy of any of the documents described in this update, please contact the Product Safety Hotline.

Brush Wellman on the Web

To better serve our customers and those interested in understanding more about beryllium-containing products, Brush Wellman maintains a website which provides access to health, safety and environmental information for beryllium-containing products. Items available on the website include Material Safety Data Sheets, Safety Facts, the Beryllium Consultant Network, Frequently Asked Questions, past Beryllium Health and Safety Updates and recent research papers. You can access our website at **www.brushwellman.com**

Other Sources of Beryllium Information

Beryllium health, safety and environmental information can also be obtained through other organizations such as OSHA, NIOSH and ACGIH. You can obtain information from these organizations by accessing their web sites at **www.osha.gov**, **www.cdc.gov/niosh** and **www.acgih.org**.

Beryllium Consultant Network

The Beryllium Consultant Network consists of professional Industrial Hygienists who have either attended an industrial hygiene training seminar on beryllium or have previous experience in controlling occupational exposure to beryllium. These consultants provide services independent of Brush Wellman. Brush Wellman assists the network consultants by providing them periodic updates through refresher courses and written correspondence. A listing of consultants in the Beryllium Consultant Network can be obtained from our website or by calling the Product Safety Hotline.